Mixed Oxidant Process for Control of Biological Growth in Cooling Towers

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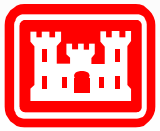

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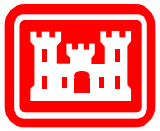
Operation of Cooling Towers

- Need to be protected from
  - corrosion
  - scale
  - microbiological growth
- Chemical treatments approaches use hazardous chemicals
  - personal safety
  - environmental protection
  - transport, storage, and disposal
- Opportunity to implement “green” treatments

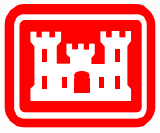
What Are "Green" Chemical Treatments?

- Reduce corrosion, biological growth and scale in heating and cooling plants with treatments that are
  - Less toxic, not environmentally persistent
  - Not bioaccumulative
  - Biodegradable to nontoxic byproducts
  - Efficient in their manufacturing process
  - Delivered into the system when needed, in correct amount



Mixed Oxidant Biocide Generation Process

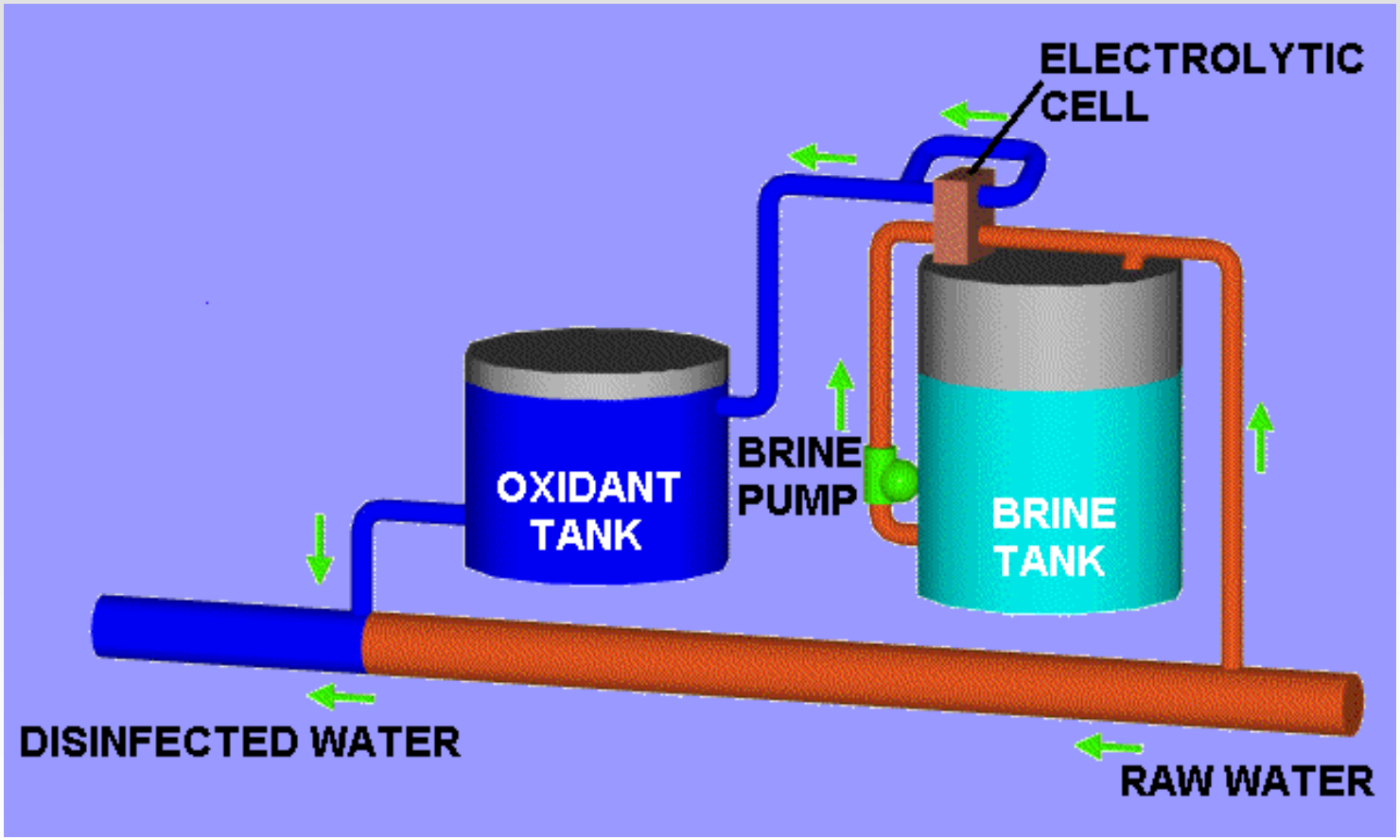
- Electrolysis of salt to generate chlorine biocides
- Small-scale electrolytic cell generates biocide on site, on demand from a feedstock of salt and water
- Can generate either hypochlorite or mixed oxidants:
  - free chlorine
  - peroxide type compounds
  - hydroxyl radicals



Mixed Oxidant Biocide Generation Process

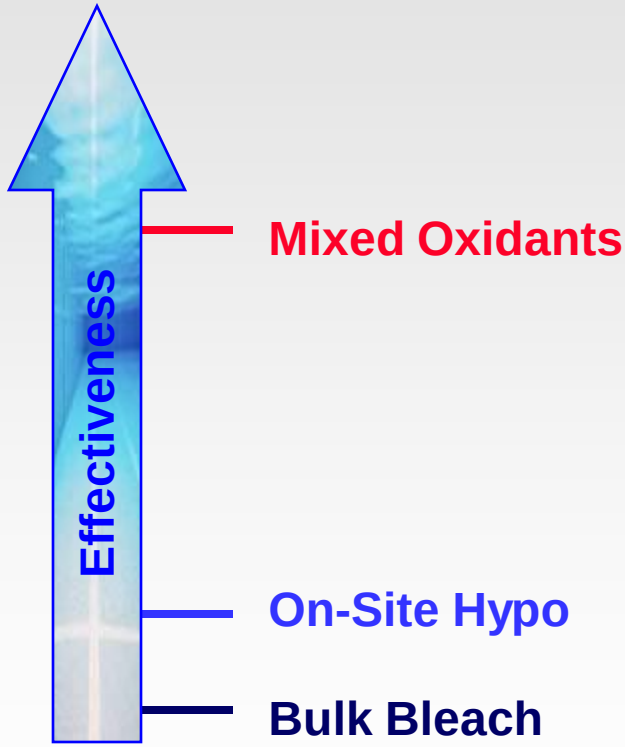
- Eliminates purchase, transport, and storage of hazardous biocide compounds such as hypochlorite or chlorine gas
- Provides a constant dosage level of chlorine to control both algae and bacteria
- Can remove existing biofilms

Mixed Oxidant Biocide Process



MIOX Offers Mixed Oxidants

- Advanced version of on-site chlorine generation
- Controls electrolytic process using patented MIOX equipment design
- Chemical and biocidal properties are more effective than conventional chlorine



Improved Safety

- Concentration is < 1% (vs. 12.5% for bulk bleach)
- Will not form chlorine gas
- No transport or storage of hazardous chemicals
- Uses only salt as feedstock

Reduced Carbon Emissions

It takes almost 5 deliveries of bulk bleach to equal the same amount of disinfectant generated by a single delivery of salt

Bulk Bleach

vs.

OSG

Reduced Corrosion

Average Metal Concentration

4 weeks exposure, 1 mg/L free available chlorine residual*

	Mixed Oxidant	Sodium Hypo
Pb	0.1	0.57
Cu	0.18	0.26

Exposed to lead, copper, and copper coupons partially coated with 50%/50% tin lead solder

Sodium hypo formed 5.7 times more lead and 1.4 times more copper than MOS

*MIOX Corporation data

System Implemented on 3 Towers

- Tower 1: MIOX unit SAL-30
  - Cooling Tower - Marley Class NC galvanized steel
  - Chiller – York Screw Chiller 180 tons
- Tower 2: MIOX unit SAL-40
  - Cooling Tower – Evapco
  - Chiller – Trane Centravac Rotary Chiller 130 tons
- Tower 3: MIOX unit SAL-40
  - Cooling Tower – Evapco
  - Chiller – Carrier Screw Chiller 96 Tons
- A fourth tower outfitted with corrosion coupons and sensors as a control

System Implemented on 3 Towers

- Corrosion and scale prevention programs remain the same
  - Nalco 2827 corrosion inhibitor
  - Sulfuric acid for control of calcium scale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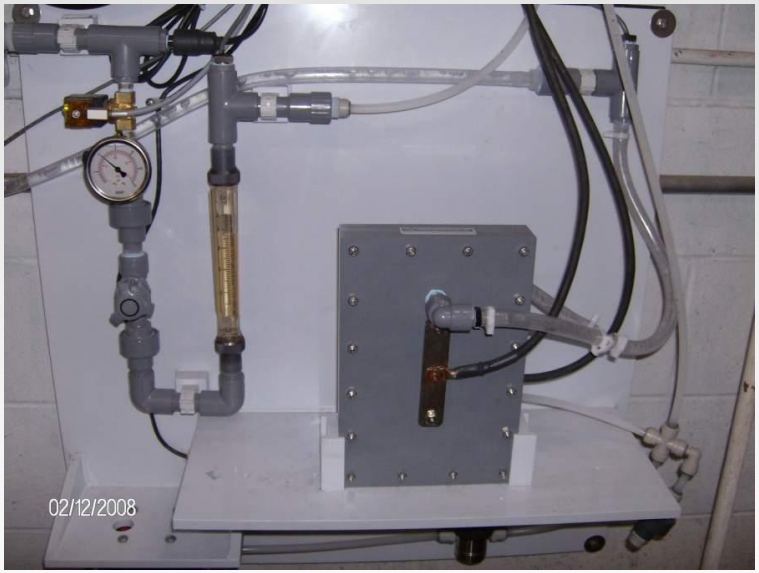
Brine and Oxidant Tanks



Electrolytic Cell

Data Collection

- Corrosion rates of copper and mild steel corrosion coupons
- Water Conditions
  - Total and free chlorine
  - Total hardness, calcium hardness
  - pH
  - Bioactivity
  - Conductivity
- LPR corrosion rates
- Documentation of biofouling

Data Collection

FIELD ANALYSES
September 2009

LOCATION	CONDUCTIVITY	pH	P ALKALINITY	M ALKALINITY	TOTAL HARDNESS	Ca HARDNESS	BACTERIA cfu / ml
Control	3140	8.8	40	380	670	520	1000-10000
Tower 1	3570	8.8	50	390	700	580	<100
Tower 2	3460	8.8	50	380	700	570	<100
Tower 3	1415	8.3	0	150	290	260	<100-100
Feedwater	905	8.3	0	120	180	130	<100

Preliminary Results

- Equipment is sensitive to changes in operating parameters -
  - Water temperature
  - Water pressure
  - Flow rates
- Microbiological growth is well controlled
- Does not contribute to excessive corrosion – but corrosion rates increase if high residuals develop during periods of low demand

Project Completion

- Analysis period continues through this summer
- Final report will be complete September 2010
  - Conclusions
  - Recommendations
  - Return on investment

Questions?